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OF
CIVIL ENGINEERS

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Vol. II DECEMBER, 1915 No. 10

BOSTON SOCIETY OF CIVIL ENGINEERS

FOUNDED 1848

PROCEEDINGS

NOTICE OF REGULAR MEETING.

A REGULAR meeting of the Boston Society of Civil Engineers will be held on

WEDNESDAY, DECEMBER 15, 1915,

at 7.45 o'clock P.M., in CHIPMAN HALL, TREMONT TEMPLE, BOSTON.

Mr. A. A. Cohill will read a paper on " The Construction of the Dorchester Tunnel under Fort Point Channel." The paper will be illustrated with lantern slides.

Ladies are invited to be present at this meeting.

S. E. TINKHAM, *Secretary*.

PAPERS IN THIS NUMBER.

" The South End Sewer System of Boston," Edgar S. Dorr.
(Presented before the Sanitary Section, November 3, 1915.)

" Laying a Small Cast-Iron Pipe across a Narrow Stream," Charles R. Gow.

" External Corrosion of Water Pipe by Sulphuric Acid," Harrison P. Eddy.

This number of the JOURNAL also contains a title page, table of contents and index for Volume II.

CURRENT DISCUSSIONS.

Paper.	Author.	Published.	Discussion Closes.
"Federal Valuation of B. & M. R. R."	F. C. Shepherd.	Oct.	Jan. 10
"The Arrowrock Dam."	C. H. Paul.	Nov.	Jan. 10

Reprints from this publication, which is copyrighted, may be made provided full credit is given to the author and the Society.

Contributors are hereby notified that proof will not be submitted to them for examination unless requested before the 10th of the month preceding the month of publication.

In addition to the professional papers presented before the Society, the JOURNAL will hereafter contain one or two brief narratives of interesting engineering experiences of members whenever they are available. They may not exceed a few paragraphs in length, and while of such a nature that they will not be suitable for presentation before the Society, they will nevertheless give valuable information. The first of these short articles appears in this issue of the JOURNAL.

EDWARD C. SHERMAN, *Editor.*

MINUTES OF MEETINGS.

BOSTON, MASS., November 17, 1915. — A regular meeting of the Boston Society of Civil Engineers was held this evening at Chipman Hall, Tremont Temple, and was called to order at 8.15 o'clock by the President, Mr. Charles R. Gow. There were present 79 members and visitors.

By vote, the reading of the record of the October meeting was dispensed with, and it was approved as printed in the November JOURNAL.

The Secretary reported for the Board of Government the election of the following to membership in the grades named:

Members — Clayton Clifford Alexander and Samuel Aubin Nash.

Associate — Theodore Reed Kendall.

Juniors — Willard Gile Burleigh and Thornton Rice Stenberg.

Memoirs of deceased members were presented as follows: That of Past President Dexter Brackett prepared by a committee consisting of Messrs. Frederic R. Stearns and Charles W. Sherman; that of Theodore L. Keppler prepared by Mr. Frederic I. Winslow; and that of Levi G. Hawkes prepared by a committee consisting of Messrs. James E. Stone and Theodore P. Perkins.

By vote, the memoirs were received and ordered printed in the JOURNAL.

The Secretary announced the death of Ernest P. Whitten, a member of the Society, which occurred on June 17, 1915, and by vote the President was requested to appoint a committee to prepare a memoir.

The President reported for the Board of Government its recommendation that an invitation be sent to the American Society of Civil Engineers to hold its annual convention for 1916 in the city of Boston, and that a committee of three be appointed by the President, of which he shall be chairman, to have charge of the matter. On motion of Mr. Fay, the recommendation was adopted by a unanimous vote.

Mr. Frank C. Shepherd then read the paper of the evening, entitled, "The Federal Valuation of the Boston and Maine Railroad." The paper was discussed by Wm. J. Cunningham, assistant professor of transportation at Harvard College; Mr. James C. Irwin, assistant valuation engineer, Boston & Albany Railroad; and Mr. Hammond V. Hayes, consulting engineer, of Boston.

Adjourned.

S. E. TINKHAM, *Secretary.*

BOSTON, MASS., November 3, 1915. — An excursion was held by the Sanitary Section, Boston Society of Civil Engineers, this afternoon, at 5 o'clock, to the new automatic sewage pumping station of the city of Boston, at the corner of Albany and Union Park streets.

The various details of the building and machinery were explained by Messrs. Edgar S. Dorr, Charles H. Dodd and other engineers of the Public Works Department.

There were 64 present.

In the evening, at 8 o'clock, a meeting was held in the Society library, Tremont Temple, at which Chairman Gage presided.

A very interesting illustrated paper on the "South End Sewer System" was read by E. S. Dorr, engineer in charge, Sewer Service, Public Works Department, city of Boston. This system includes the pumping station visited in the afternoon.

There were 32 present at the meeting.

FRANK A. MARSTON, *Clerk.*

APPLICATIONS FOR MEMBERSHIP.

[December 3, 1915.]

THE By-Laws provide that the Board of Government shall consider applications for membership with reference to the eligibility of each candidate for admission and shall determine the proper grade of membership to which he is entitled.

The Board must depend largely upon the members of the Society for the information which will enable it to arrive at a just conclusion. Every member is therefore urged to communicate promptly any facts in relation to the personal character or professional reputation and experience of the candidates which will assist the Board in its consideration. Communications relating to applicants are considered by the Board as strictly confidential.

The fact that applicants give the names of certain members as reference does not necessarily mean that such members endorse the candidate.

The Board of Government will not consider applications until the expiration of twenty (20) days from the date given.

DAVIS, THOMAS C., Newton Highlands, Mass. (Age 40, b. Walpole, N. H.) Graduate of Worcester Polytechnic Inst., 1899, civil engineering course. From 1899 to March, 1900, foreman on sewer construction for City of Worcester; from 1900 to 1904, with Shiffler Bridge Co., which became the American Bridge Co. and then the Pittsburgh Const. Co. during this period; work here included that of designer, estimator and superintendent of construction; from 1904 to 1911, with various engineering concerns, chiefly as superintendent of construction or on design of steel and concrete; is now employed by Morrison & Young, contractors, Salem, Mass. Refers to C. M. Allen, H. P. Eddy and A. L. Fales.

Johnson, Frank W., Brooklyn, N. Y. (Age 26, b. East Boston, Mass.) Student for three years at Franklin Union, civil and hydraulic engineering courses, and for one year at West Side Y. M. C. A., New York; is now student at Brooklyn Polytechnic Inst., civil engineering course. From 1909 to 1910, draftsman with Orcutt Automatic Train Stop Co., Boston; from April, 1910, to date, assistant designing engineer with Ambursen Co., New York. Elected a Junior, March 19, 1913, and now desires to be transferred to grade of Member. Refers to J. W. Bickford, H. L. Coburn, C. H. Eglee, W. F. Farley and E. H. Rockwell.

Peacock, Frank Edward, Rockford, Ill. (Age 20, b. Rockford, Ill.) Student at Mass. Inst. of Technology, civil engineering course; was student at Technology summer surveying camp, July to September, 1915. Refers to C. B. Breed, A. E. Burton, G. L. Hosmer, J. W. Howard and A. G. Robbins.

Snow, Leslie Whitmore, Boston, Mass. (Age 25, b. Snowville, N. H.) Graduate of Dartmouth College, 1912; graduate of Mass. Inst. of Technology, civil engineering course, 1914. Has had five months' practical experience in surveying, and is now with Woonsocket Machine & Press Co. and Ames Plow Co. on system work in plant. Refers to A. E. Burton, W. H. Coburn, A. G. Robbins, G. E. Russell and C. M. Spofford.

Sokoll, Jacob Max, New Haven, Conn. (Age 26, b. Kerson, Russia.) Graduate of Tufts College, civil engineering course, 1913. Was employed temporarily after graduation with Water Division, High Pressure Fire Service of Boston; and as structural detailer and draftsman with New England Structural Co.; from Dec., 1913, to date, timekeeper, rodman, engineer and steel foreman with Aberthaw Construction Co. Elected a Junior, December 17, 1913, and now desires to be transferred to grade of Member. Refers to L. H. Allen, S. L. Conner, J. A. Garrod, A. B. MacMillan, E. H. Rockwell and F. B. Sanborn.

LIST OF MEMBERS.

ADDITIONS.

Kendall, Theodore R. .... 93 Gainsboro St., Boston, Mass.
Nash, S. Aubin .... 77 Toxteth St., Brookline, Mass.
Stenberg, Thornton R. .... 99 Salisbury St., Worcester, Mass.
Whitmore, Harold C. .... 57 Bartlett Ave., Pittsfield, Mass.

CHANGES IN ADDRESS.

Badger, Frank S. .... 43 Exchange Pl., New York, N. Y.
Balch, Wm. H. .... 46 Green St., Boston, Mass.

Blake, E. M. . . . . Hyde Park, Mass.
Dolliver, Henry F. 550 Haverhill St., Lawrence, Mass.
Doten, Charles C. . . . . Box 345, Plymouth, Mass.
Herrick, Henry A. 201 Devonshire St., Boston, Mass.
Hoyt, Laurence B. 168 E. Emerson St., Melrose, Mass.
Jeffers, Robert B. . . . . 121 N. Fitzhugh St., Rochester, N. Y.
Moore, Chester A. . . . . 95 Pennsylvania Ave., Somerville, Mass.
Phelan, John J. . . . . 403 G St., Northeast, Washington, D. C.
Raymond, John W., Jr. . . . . 165 Tracy Ave., Lynn, Mass.
Soutar, George P. 33 Chestnut St., East Lynn, Mass.

DEATH.

Whitten, Ernest P. . . . . June 17, 1915

EMPLOYMENT BUREAU.

The Board of Government maintains an employment bureau for the Society, to be a medium for securing positions for its members and applicants for membership, and also for furnishing employees to members and others desiring men capable of filling responsible positions.

At the Society room two lists are kept on file, one of *positions available* and the other of *men available*, giving in each case detailed information in relation thereto.

Men Available.

305. Age 23. Graduate of Mechanic Arts High School, 1910; is now student in structural course at Lowell Inst. Has had more than three years' experience as draftsman, including one and one-half years with the Edison Electric Illuminating Co.; eight months with General Electric Co. of Lynn; seven months with Swift & Co., in construction department; two months with Aberthaw Construction Co.; and four months with various engineering concerns. Desires position as draftsman or on outside work.

337. Age 27. Received technical education from evening study. Has had eight years' experience, four years of which were spent on design of engineering structures, specializing in reinforced concrete; experience includes field work, inspection, drafting, etc., on railroads, Panama Canal, ocean terminals, reclamation and irrigation. Desires position along engineering lines. Salary desired, $125 per month.

LIBRARY NOTES.

RECENT ADDITIONS TO THE LIBRARY.

U. S. Government Reports.

Annual Report on Statistics of Railways in United States for 1912–13.

Comparative Railway Statistics of United States and Foreign Countries in 1912.

Distribution of Magnetic Declination in United States for January 1, 1915. Daniel L. Hazard.

Northern Hardwood Forest: Its Composition, Growth and Management. E. H. Frothingham.

Proceedings of Naturalization Reception, Philadelphia, 1915.

Results of Magnetic Observations Made by United States Coast and Geodetic Survey in 1914. Daniel L. Hazard.

State Highway Mileage and Expenditures to January 1, 1915.

Triangulation along Columbia River and Coasts of Oregon and Northern California. Charles A. Mourhess.

Triangulation in West Virginia, Ohio, Kentucky, Indiana, Illinois and Missouri. A. L. Baldwin.

State Reports.

Massachusetts. Annual Report of Highway Commission for 1914.

Ohio. Report of State Board of Health of Study of Collection and Disposal of City Wastes in Ohio, 1910.

Wisconsin. Peat Resources of Wisconsin.

Wisconsin. Annual Reports of Railroad Commission for 1910–13.

Municipal Reports.

Buffalo, N. Y. Corporation Proceedings containing Reports of American Public Health Association and of Rudolph Hering on Purification of Water Supply.

Buffalo, N. Y. Annual Report of Bureau of Water for 1914–15.

Lynn, Mass. Annual Report of Commissioner of Water and Water Works for 1914.

Medford, Mass. Annual Report of City Engineer for 1914.

Minneapolis, Minn. Official Laws Regulating Construction, Alteration, Maintenance, Repair and Removal of Buildings.

New Orleans, La. Report to Sewerage and Water Board on Hurricane of September 29, 1915, and Subsequent Heavy Rainfalls.

Newton, Mass. Annual Report of Street Commissioner for 1914.

Salt Lake City, Utah. Annual Reports of City Officers for 1914.

Salt Lake City, Utah. Appropriation Budget for 1915.

Miscellaneous.

American Society for Testing Materials. Proceedings for 1915. 2 vols.

Bay State Street Railway Company: Report on Property and Business, 1915. Gift of H. S. Knowlton.

Boston Directory, 1914. Gift of W. B. Conant.

Canada, Department of Mines: Electrothermic Smelting of Iron Ores in Sweden. Alfred Stansfield.

Chemical Rubber Company, Cleveland, Ohio: Handbook of Chemistry and Physics, 1914.

Cooling Ponds for Condensing Engines. Lee H. Parker, President Spray Engineering Co.

Great Southern Lumber Company: Select Structural Material.

International Irrigation Congress: Proceedings for 1914.

Keuffel & Esser Company: Catalogue of Drawing Materials, Surveying Instruments, etc., 1915.

Massachusetts Peace Society: Arithmetic of War; America's International Ideals; Practical International Program; Agencies for Promoting World Order. Jay William Hudson.

National Fire Protection Association: Fire Protection in Schools.

New International Encyclopædia, vols. 13 to 16, inclusive.

LIBRARY COMMITTEE.

Among the big uplift movements under way is the filling in of seventy-five acres of Boston Harbor flats now under water. — *Boston Herald.*

NEW ENGINEERING WORK.

(Under this head a brief description of new engineering work contemplated or under construction will be presented each month. Engineers and contractors are requested to send descriptions of their work to the Secretary, 715 Tremont Temple, Boston, before 1st of each month.)

Commonwealth of Massachusetts.—METROPOLITAN WATER AND SEWERAGE BOARD. — *Water Works.*

Pipe Lines. — About 80 per cent. of the work of laying 14 370 lin. ft. of 60-in. cast-iron pipe in Commonwealth Ave., between Prince St. and the Charles River, in Newton, has been completed. The contractors are Andrew M. Cusack, of Boston, and Charles A. Kelley, of Somerville.

Bellevue Reservoir. — The work on the granite masonry tower, which encloses the new steel tank (100 ft. in diameter by 44 ft. high) on Bellevue Hill, West Roxbury, is completed and the steel work for the roof is in place. About one half of the reinforced concrete floor is laid, and work is started on the terra-cotta walls.

METROPOLITAN WATER AND SEWERAGE BOARDS. — *Sewerage Works.* — Work is in progress on Sections 105 and 106 of the Wellesley Extension Sewer and on the temporary outfall for the Deer Island outfall extension.

The contract for the reconstruction of the Malden River siphon has been awarded.

Plans are nearly ready for Sections 103 and 104 of the Wellesley Extension Sewer.

METROPOLITAN PARK COMMISSION. — *Charles River Reservation.* — Bids have been received for building reinforced concrete bridge over the Charles River at North Beacon St., Boston and Watertown, and the contract awarded to A. G. Tomasello, the lowest bidder.

Plans and specifications are being prepared for bridge over the Charles River to Commonwealth Ave., between Newton and Weston.

Work of grading, surfacing and other work from Charlesbank Road to Brooks St., Newton and Boston, is in progress. Rowe Contracting Co., contractor.

Work of excavating channel of Charles River from Elm St. to Bleachery Dam, Waltham, is in progress. John R. Burke, contractor.

Furnace Brook Parkway. Work of construction of parkway extension from Quincy Shore Reservation to Hancock St. is in progress. John Cashman & Sons Co., contractor.

Work of building reinforced concrete girder bridge across Blacks Creek for Furnace Brook Parkway Extension is in progress. Hugh Nawn Contracting Co., contractors.

Mystic Valley Parkway. — Work of excavating the channel of Aberjona River from Boston & Maine Railroad bridge to Waterfield St., Winchester, is in progress. Coleman Brothers, contractors.

Revere Beach Reservation. — Work of constructing concrete shore protection from Bath House Shelter to Revere Street Shelter is in progress. Coleman Brothers, contractors.

DIRECTORS OF THE PORT OF BOSTON. — *Dry Dock.* — The work under the contract with the Holbrook, Cabot & Rollins Corp. for the construction of the dry dock at South Boston is in progress. The contractor is assembling the plant and at the present time is dredging the dry dock site at the rate of 5 000 cu. yds. of material per day.

East Boston. — The Directors received bids on November 24, 1915, for two contracts, one for building a bulkhead and filling around the same and the other for dredging and filling on state flats at East Boston. The contract for bulkhead and filling was awarded by the Directors on November 29 to the Bay State Dredging and Contracting Co. Under this contract there will be constructed about 2 200 lin. ft. of bulkhead and about 170 000 cu. yds. of filling. Bids were received also from Coleman Bros. and from H. P. Converse & Co. The prices submitted for the bulkhead ranged from $21 to $23.94 per lin. ft. of bulkhead. Prices for filling varied from 18.7c to 41.5c per cu. yd.

The bulkhead will extend easterly from the end of Maverick St. and be constructed of 6-in. yellow pine sheeting and oak piles in bents 6 ft. apart, one vertical pile and two spur shore piles in each bent. Filling is to be placed on both sides of the bulkhead to an elevation of 10 ft. above mean low water, leaving at this elevation a berm 10 ft. wide on both sides and allowing the material to take its natural slope.

Only one bid was received for the other contract, namely, that of H. P. Converse & Co., for dredging and filling, involving the handling of about 1 500 000 cu. yds. of material.

Dredging. — During the past month there has been dredging under contracts by the Directors of about 20 000 cu. yds. of material for the improvement of minor channels in the harbor. The Directors are receiving proposals for leasing of a large suction dredging plant for use in Boston Harbor.

South Boston. — The Directors propose to grade D St. between Fargo and Egmont streets and install a sewer in Fargo St. between C and D streets, South Boston.

Boston Transit Commission. — *Dorchester Tunnel.* — Section D, including the station in Dewey Square, which is to be known as "South Station Under," the Hugh Nawn Contracting Co., contractor for all heavy work, is practically done. The work of finishing the interior of the station with tile, terrazzo and white cement plaster remains to be done and is now in progress.

Section E was described in the October JOURNAL, p. 9*. The shield for the easterly tunnel, which was started first, is half way between West First St. and Summer St., and the westerly tunnel shield is just going under the water. P. McGovern & Co. is the contractor.

Section G is located in Dorchester Ave. between West Fourth St. and Old Colony Ave., and is about 1 280 ft. long. The structure is to be mainly of reinforced concrete. The work includes a pump well with an emergency exit, a ventilating chamber with an emergency exit, an open incline for surface cars, a 6 ft. 6 in. tidegate chamber on the B St. outfall sewer, and sewer changes. Coleman Bros. are the contractors.

Section H is located in Dorchester Ave. and extends from Old Colony Ave. to within about 300 ft. of Andrew Square. The structure is to be mainly of reinforced concrete, and consists of a single-span double-track tunnel excepting for about 200 ft. at its southerly end, where a middle wall will separate the tracks in the tunnel, all to be built by the cut-and-cover method. The work also includes a pump well, an emergency exit and sewer changes. The excavation has been nearly completed. The T. A. Gillespie Company is the contractor.

East Boston Tunnel Extension. — The Commission's work on the East Boston Tunnel Extension is practically completed, with the exception of the Otis inclined escalator, leading to the street surface in Scollay Square, which is being installed for the "Scollay Under" Station.

City of Boston. — PUBLIC WORKS DEPARTMENT, HIGHWAY DIVISION, PAVING SERVICE. — Work is in progress on the following streets:

Gladstone St.,	Walley St. to Upland St.	Artificial stone sidewalks.
Mackin St.,	Western Ave. to Waverly St.	Bitulithic.
Chapin Ave.,	Mt. Vernon St. to Preston Rd.	Tar macadam.
Prince St.,	Pond St. to the Arborway.	Asphalt.
Dane St.,	Holbrook St. to Orchard St.	Asphalt.
Elgin St.	Centre St. to W. R. Branch R. R.	Asphalt.
Glendower Rd.,	Kittredge St. to Poplar St.	Asphalt.
Montebello Rd.,	Forest Hills St. to Walnut Ave.	Bitulithic.
Spring St.,	At hospital grounds.	Fence.
Oakland St.,	River St. to Rockdale St.	Asphalt macadam.
Jones Ave.,	Mascot St. to Ballou Ave.	Asphalt.
Rosewood St.,	Oakland St. to Randolph Rd.	Asphalt.
Creighton St.,	Centre St. to Day St.	Artificial stone sidewalks.

The Fore River Shipbuilding Co., Quincy, Mass., has the following work in progress:

Twenty-seven submarine boats.
Oil tankers *Texas* and *New York*.
Cargo vessel *Cubadist*.
Freight steamers *Edward Luckenbach* and *Julia Luckenbach*.
Molasses steamers *Sucrosa* and *Mielero*.
Two freight steamers for the Texas Company.

Vol. II DECEMBER, 1915 No. 10

BOSTON SOCIETY OF CIVIL ENGINEERS
FOUNDED 1848

PAPERS AND DISCUSSIONS

This Society is not responsible for any statement made or opinion expressed in its publications

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THE SOUTH END SEWER SYSTEM OF BOSTON.

BY EDGAR S. DORR,* MEMBER BOSTON SOCIETY OF CIVIL ENGINEERS.

(Read before the Sanitary Section, November 3, 1915.)

THE problem of the relief of the South End Sewer System was a peculiar one. The territory which suffered from bad sewerage conditions, containing about 190 acres, is bounded roughly by Dedham, Tremont and Northampton streets, the N. Y., N. H. & H. Railroad, Tremont and Dover streets, and the South Bay. It is flat and is laid out on the alleyway plan; the streets are graded at about elevation 17, the alleys are generally lower than the streets — in some places 6 or 7 ft. lower — back yards are at the level of the alleys or lower, and basement kitchens and dining rooms are at the yard level. Some of these basements are as low as grade 6, many at 7, and large numbers between 7 and 9.

The sewer system is on the combined principle, delivering its dry-weather flow into the East Side Intercepting Sewer in Albany St., and its storm water flow into the South Bay. When it is considered that the intercepter can carry away only a small fraction of the storm run-off of this acreage, and that mean high tide is elevation 10, mean spring tide elevation 12,

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NOTE. Discussion of this paper is invited, to be received by Edward C. Sherman, Editor, 6 Beacon Street, Boston, before February 10, 1916, for publication in a subsequent number of the JOURNAL.

* Office Engineer, Sewer Div., Dept. of Public Works, Boston.

and still higher tides not infrequent, it will be realized that this district, with its peculiar arrangement and grading of streets, alleys, yards and basements, could hardly have been planned more effectively to produce trouble if it had been done intentionally.

Of course, it was not so done. How, then, did it come about?

To answer this question it is necessary to go into history. It is interesting, however, to trace this peculiar development as it is an example of what serious evils result from the growth of cities without any general plan.

In the beginning, the South Bay and the Back Bay, both areas of flats covered at high water, nearly met, being separated only by the narrow strip of land called Roxbury Neck, with its one road, Washington St. The filling of the flats naturally proceeded both ways from Washington St. Very early came the water-power project, with the milldam damming off the Back Bay from Charles River and furnishing power for tide-mills. Tide-mills cannot run at high tide, and to obviate the trouble a cross-dam was built, dividing the mill pond into two parts, one of which was kept empty, or as nearly so as possible, and used to discharge the water from the other into during the period of high tide in the river, in this way permitting the tide-mills to run full time.

Beacon St. occupies the site of the mill-dam and Hemenway St. that of the cross-dam. The part of the mill pond west of Hemenway St. was called the "Full Basin"; that between Hemenway, Pleasant and Charles streets was called the "Receiving" or "Empty Basin."

All the sewerage troubles of the South End have arisen from the creation of this Empty Basin and its effect upon the development of the adjacent land. The elevation of the water surface was kept at or below elevation 3 at all times. This made of the basin a huge storage reservoir, protected from high tides and affording a low outlet for the sewers which were built to drain the land made by filling the flats. This condition fostered a cheap development. Filling was saved by grading alleys, yards and basements at a low elevation, and no flooding resulted to check this tendency, as would have been the case if the sewers had been subject to tidal influence. Inasmuch as the Empty Basin was regarded as permanent, this course of events was perfectly natural.

The Basin, satisfactory as a safeguard against floods, was not so satisfactory from a sanitary point of view. We learn from the report of the Committee on Sewers of 1868, consisting of Joseph F. Paul, Newton Talbot and Moses Fairbanks, that it became "evident that this stagnant basin was becoming a gigantic cesspool, and that some plan must be devised for diverting the drainage from it. Accordingly, in 1850–51 a large sewer was built, under plan of Messrs. Chesborough and Parrett, running the whole length of Tremont St., intercepting the outlets of the cross-sewers, and thence down Dover St. to the South Bay. . . . When a heavy rain occurred, however, during this interval (i. e., during high tide), it was arranged to discharge this extra water as before into the Back Bay, by overflows or weirs left for that purpose, and so keep down the level in the sewers."

It is evident from the above quotation that the main reliance for protection against flooding was still placed on the Empty Basin.

The filling of the whole Back Bay, including the Empty Basin, began about 1860, and was in rapid progress in 1862. The disastrous effect that this would have upon sewerage conditions in the South Bay was not unforeseen, as is shown by the building, in addition to the Tremont and Dover streets sewer, of large storage sewers in East Dedham St. in 1857, Union Park St. in 1865, and East Concord St. in 1869, all draining into the South Bay. In short, the plan of turning the drainage of the whole district from the Back Bay to the South Bay was adopted, and to build the main sewers large enough to afford some storage at times of high tide. This is really about all that could be done, short of establishing a pumping station, or raising the whole district bodily, buildings, streets and all. This was done in two instances; the Church St. district, 15 acres, was raised in 1868–1869, at a gross cost of $1 183 363. The sale of the estates after the improvement realized $222 291, making the net cost to the city $960 441. The Suffolk St. District, 34 acres, was raised in 1870–72, at a gross cost of $2 248 986 and a net cost of $1 565 566.

Other large expenditures occurred about the same time, $1 584 251 for the razing of Fort Hill in 1869–72, and the heavy loans on account of the great fire, $404 674 in 1872, and $5 000 000 in 1873. These were large sums for the City of Boston in the '70's, and these expenditures probably had much to do with the subsequent disinclination of the City Government to attack the larger problem of the South End in general. The condition of these two districts was considerably worse than that of the rest of the South End, as is easily seen from their location in reference to the Empty Basin.

With the completion of the filling of the Back Bay, including the Empty Basin, all hope of relief from this direction ceased; the South End was left a flat area, draining its storm water into the South Bay, under tidal conditions, and so graded that its lowest portions were situated at the upper ends of its sewer systems, 4 000 ft. from the outlets into the South Bay. (Fig. 1.)

Floodings were the inevitable result. While the sewer system was adequate to discharge the storm water of quite heavy rains, provided they occurred at low tide, and its storage sewers had capacity to store the run-off of very short violent showers at high tide, whenever a heavy rain lasted over a high tide, the storm water, polluted with sewage, unable to flow into the South Bay without rising to an elevation higher than the tide, was stored in the low basements, yards and alleys until the next low tide, when it was discharged.

The only thing which was done by the city to alleviate this condition, up to the time of the building of the low-level pumping system about to be described, was the building of the intercepting system, or "Improved Sewerage," so called. This was completed in 1884. The amount of assistance that this system can render is limited to the capacity of the East Side Intercepter in Albany St. The capacity of this sewer running full is about 61 sec.-ft. The storm water run-off of the South End is approximately 500 sec.-ft. It is evident that the most this sewer could do, with all flow from above Dover St. shut off by a regulator,

FIG. 1.
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OF CIVIL ENGINEERS
DECEMBER, 1915
DORR ON
THE SOUTH END SEWER SYSTEM
OF BOSTON

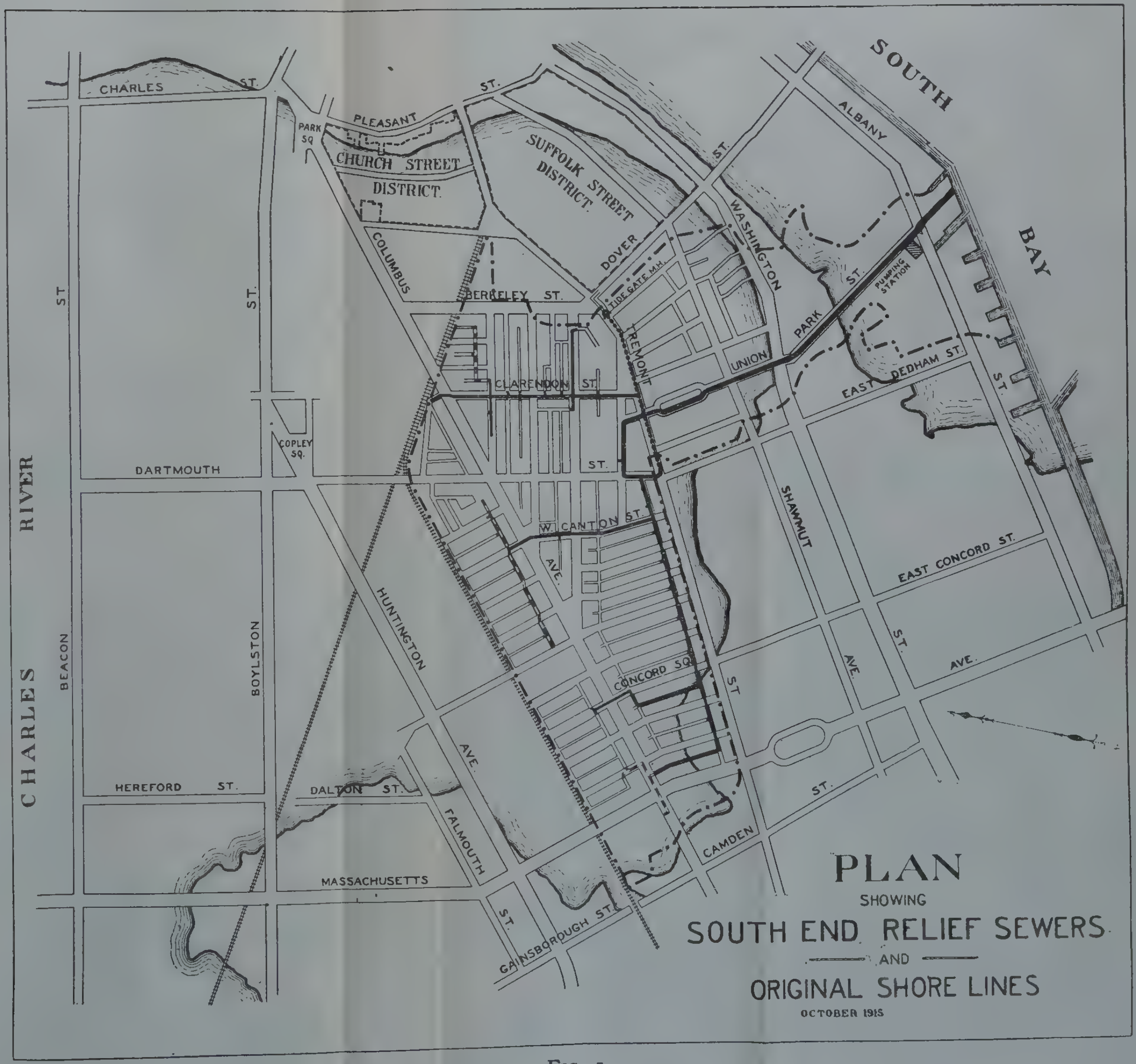

Fig. 1.

would be to take care of some small storms, keep the level of the sewage in the system down somewhat below what it would otherwise be in large storms and in some cases drain down the whole system before the tide could do it, when rain would cease a considerable time before low tide, and thereby reduce flood damages somewhat. But it could not prevent flooding. It was, however, used for all it was worth by giving open connections from the Dover and Dedham streets systems into the intercepter, because these were the lowest districts.

With the exception of the limited assistance rendered by the intercepting system, the South End has remained in the condition in which the filling of the Back Bay left it, in 1870, up to July 1, 1915, when the pumps were put in operation for the first time, during the phenomenal downpour of that date.

By the way, not a single complaint was received from the South End on account of that storm, although the tide ranged from elevation 9.40 to elevation 6.50 during the heaviest downpour.

During all this time there have been innumerable complaints and many investigations, but nothing done until recently, and the reason is that every investigation has led to the same conclusion as that reached by the Sewer Committee of 1868, previously referred to, — i. e., that nothing really effective could be done except by pumping.

In old times this could mean nothing less than a steam pumping station, and one particularly difficult and expensive to maintain, on account of the intermittent character and irregularity in time of the service to be required of it. Inasmuch as a rain heavy enough to call it into action is liable to occur at any time, day or night, the station would have to be kept with banked fires and steam up at all times. This would require three shifts of men every twenty-four hours, and yet they would be idle the greater part of the time, sometimes for weeks together.

The cost of installing an adequate station was estimated by the Sewer Committee of 1868 at $200 000.

These conclusions seem to have effectively prevented any action.

The perfection of centrifugal pumps and electrical machinery and the establishment of reliable sources of electrical energy made a resort to steam unnecessary, and the station recently completed has been designed to be electrically driven and automatically controlled throughout. The starting and stopping of the pumps is governed by the height of the sewage, and very little attendance, comparatively, will be required.

When the problem came to be taken up seriously by the Sewer Division, various expedients were considered. It was evident at once that a resort to the separate system would do no good for, because of the peculiar grading of the district, flooding would have continued from the rain falling on the area of low yards and alleys enclosed between the streets, even after the cellars and basements had been connected with a system of sanitary sewers running to the intercepter.

It was also suggested that by throwing a dam across Fort Point Channel and excluding the tide, the South Bay could be made to serve the same purpose that the Empty Basin had. If the water level could be held down to an elevation between 5 and 7, the existing sewers would be adequate to drain all the South End except the Union Park St. area, which even then would require pumping, but with a low powered station. The objections were many but not insuperable. The dam would have had to be furnished with a lock, and it would have been an impediment to navigation, but not a serious one. The channel, the dock and a part of the bay would also have had to be dredged to restore the same depth of water at the permanent low level as is now enjoyed at high tide.

But the most serious objection was that the whole bay would become a huge sewage pool, from the overflows of the combined sewers, just as the Empty Basin had become. This condition would call for some provision for flushing out and changing the water. This requirement could be met by throwing a dam across Old Harbor, creating a reservoir of clean sea water, which, if conducted through a conduit of adequate size, would have served to replace the polluted water of the South Bay. It would be quite feasible to do this, the flow from the Old Harbor reservoir through the conduit to the South Bay and out through Fort Point Channel to be established at such times as the harbor tide was below the fixed height of water in the South Bay. Indeed, a plan for doing just this has been prepared and a report made as an alternative to the plans proposed by the special commissioners on the condition of the Old Harbor, the essential feature of the report of the Sewer Office being that the problems of the unsanitary condition of the Old Harbor and the South Bay should be solved together in this way, and that such joint solution would be more economical than to attempt to solve the two problems separately. It is not improbable that this may yet be done, on account of the condition of the South Bay, which, even now, under tidal conditions, is little better than a pool of sewage. If this does happen, little will have been lost, the only difference being that a smaller pumping station would have sufficed.

This scheme evidently was developing into too large a proposition to be immediately practicable; and there was also the uncertainty as to the final disposition to be made of the South Bay, one proposition rather strongly supported being to fill it all up. This does not seem to be at all probable in view of the great value of this canal to the business interests of the city, but the possibility was enough to put a damper on a scheme so comprehensive as to include the Old Harbor, the South Bay and the South End sewerage. Inasmuch as some pumping would have had to be done in any event, it seemed the part of wisdom to lay out a pumping system to relieve the worst parts of the sewer system, and leave the larger problems for solution later.

The sewer systems of the South End are four in number, the mains lying in Dover, Union Park, East Dedham and East Concord streets. The drainage areas are not very distinctly defined on account of the numerous cross connections which have been made from time to time, apparently in efforts to relieve one locality at the expense of another. Two of these districts, Dover and Dedham streets, were especially favored by having open connections with the intercepter in Albany St., that is, there were no regulating valves interposed upon their connections with the intercepter, giving to these districts the benefit of the full capacity of the intercepter.

The Dover, Dedham and Union Park streets system had overflow outlets of reasonable size from Albany St. to the South Bay; that of Concord St. was very inadequate, being only 4 ft. by 4 ft., whereas the Concord St. sewer was 5 ft. by 8 ft.

The first work done for the relief of the South End was to rebuild this outlet of ample size, 6 ft. 9 in. by 7 ft. 9 in. This was done in 1912. It was hoped that this enlargement of outlet, together with the connection of the worst portions of the system with the pumping system, would improve conditions enough to obviate the necessity of building a pumping station on the Concord St. system, and results so far seem to justify that hope.

The policy to be followed was plain. Only those portions of the district which suffered most from flooding were to be reached by a low level system of sewers connected to a pumping station, while all those portions of the district high enough to drain by gravity were to continue so to drain, thus minimizing the amount of water to be handled by the pumps.

The district being already completely sewered, all of the existing sewers which drained areas high enough to drain by gravity were to be continued in service, and also all the sewers in the low alleys which were large enough and in fair condition were to be utilized by giving them a free outlet into the pumping system. (Fig. 1.)

Levels were taken all over the district in the cellars, basements, yards and alleys, and inquiries made as to floodings. The area finally blocked out for service by the new system included all of the Union Park St. area, a part of the Dover St. area bounded approximately by Tremont, Dover, Groton, Washington and Union Park streets and the upper or northwesterly portions of the Dedham and Concord streets areas — roughly, those portions lying northwest of Tremont St., between Northampton and Dartmouth streets, and extending northwesterly from Tremont St. about half way to Columbus Ave. and Warren Ave.

The total area to be served corresponds curiously well with the outlines of that part of the Empty Basin which lay to the east and south of the N. Y., N. H. & H. Railroad.

The first plan attempted was to drain into the main intercepting sewer in Massachusetts Ave., which would have sent the flow to the Moon Island outlet. A pumping equipment of low power only would have been required. The lift would have been low and it would have worked only when the water in the main was too high to allow gravity drainage from the new projected system.

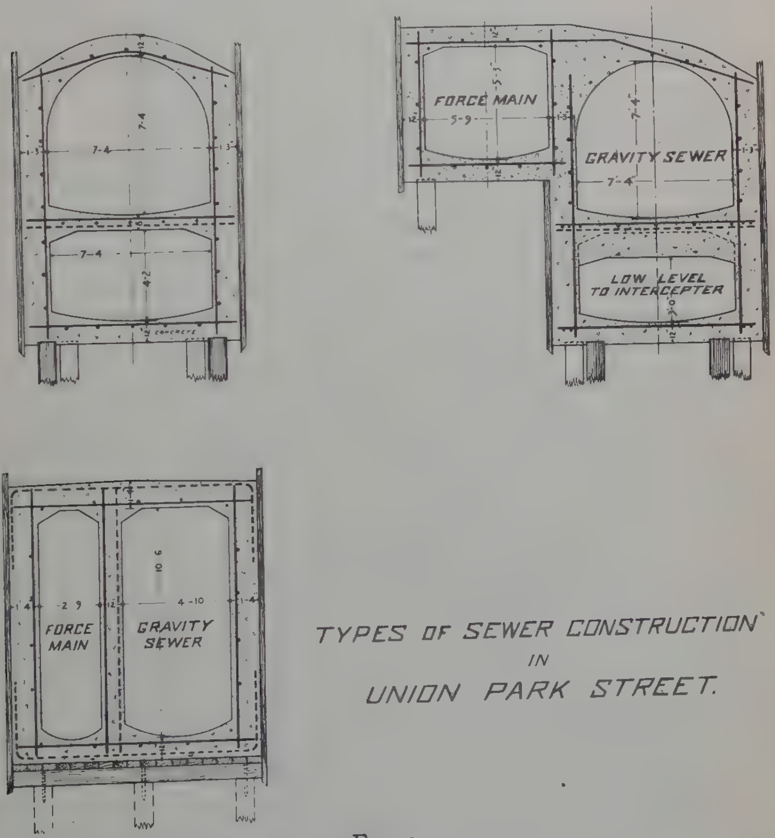

FIG. 2.

The system of sewers was planned, but as the scheme was developed it was perceived that the quantity of water to be thrown into the main would be more than it and the Calf Pasture Pumping Station could handle without imperiling their other function of holding down the level of sewage in the Dover and

Dedham streets districts, and also the Church St. district, which has a similar open connection with the West Side Intercepter. This plan was therefore abandoned, and no other alternative remained except to pump into the South Bay.

This is a less desirable outlet than Moon Island. To divert the flow to Moon Island would have improved the condition of the South Bay, but on the other hand to continue to discharge into it is no detriment because no more polluted water will be discharged into it than formerly. The same quantity will be discharged into it, but in less time.

With the direction of flow of the projected low-level system of sewers determined to be toward the South Bay, the next step was to select a line for the location of the main. Of the four main sewers of the South End, Dover, Dedham, Concord and Union Park streets, the first three were in fairly good condition, but a large part of the Union Park St. sewer was of wood and in rotten condition. For this reason, and also because it was the most direct line to the areas requiring relief, it was determined to rebuild this sewer, and to put in, in the same trench and on the same foundation, the mains for both the low-level and the high-level systems which the district would require. From the outlet nearly to Washington St., pile foundation was required, and to get the whole structure on one foundation, and to minimize excavation, a peculiar section was designed, which might be called a sewer with a horizontal septum; or one sewer superimposed upon another. (Fig. 2.) The top sewer takes the flow from all street surfaces, front roofs and all other parts of the district high enough to drain by gravity, while the lower sewer drains all those portions which will not drain by gravity at high tide and connects with the pumping station. (Fig. 3.)

The top sewer is built at about the same elevation as the old sewer which it replaces, discharges its dry-weather flow into the intercepter in Albany St. through a sump and regulator, and its storm flow through an overflow outlet to the South Bay when the intercepter is full; operating in all respects the same as the old sewer.

The low-level sewer lies underneath the top sewer, connects with the intercepter and discharges its dry-weather flow into it

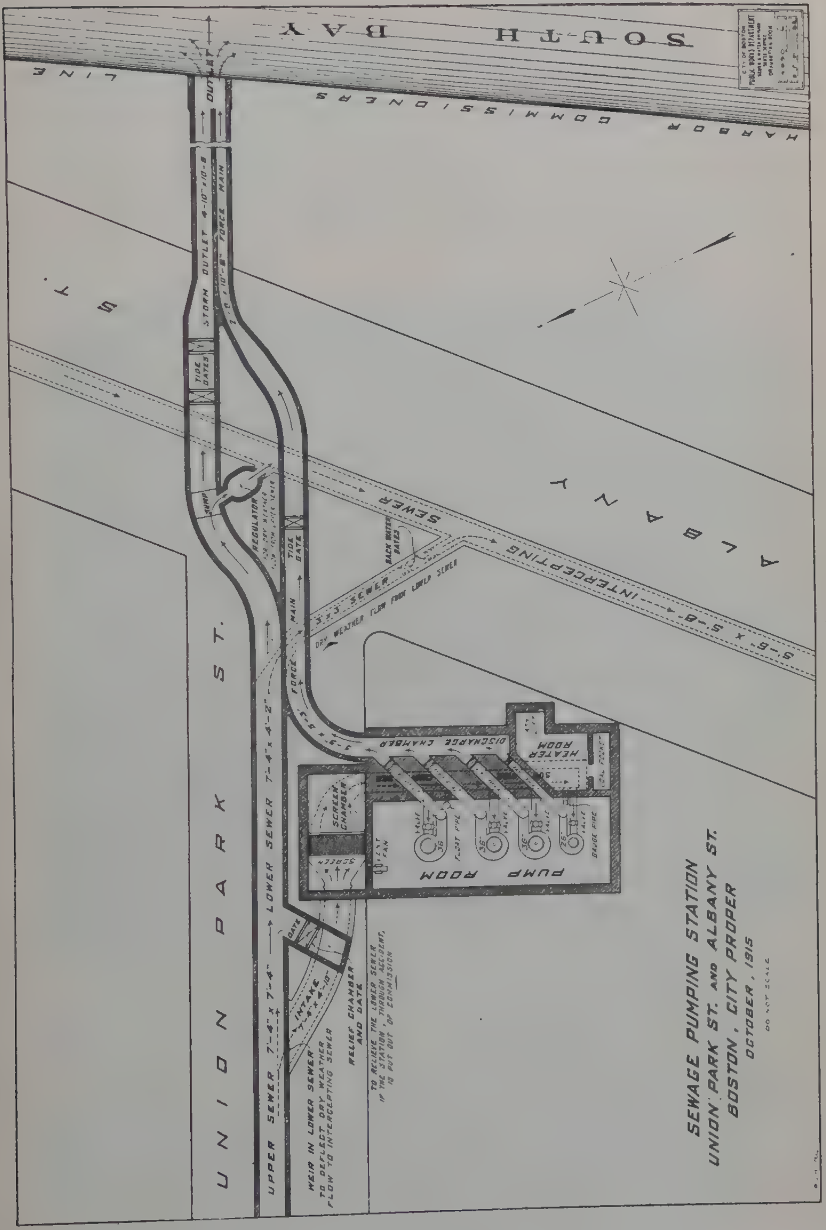
SOUTH BAY
HARBOR COMMISSIONERS LINE
CITY OF BOSTON
PUBLIC WORKS DEPARTMENT
OUTLET
STORM OUTLET 4'-10" x 10'-8"
2'-8" x 10'-8" FORCE MAIN
TIDE GATES
TIDE GATE
SUMP
REGULATOR
FOR DRY WEATHER FLOW FROM UPPER SEWER
FORCE MAIN
ALBANY ST.
5'-6" x 5'-8" INTERCEPTING SEWER
BACK WATER GATES
3' x 3' SEWER
DRY WEATHER FLOW FROM LOWER SEWER
UNION PARK ST.
UPPER SEWER 7'-4" x 7'-4"
LOWER SEWER 7'-4" x 4'-2"
3'-3" x 5'-5"
DISCHARGE CHAMBER
HEATER ROOM
COAL POCKET
SCREEN CHAMBER
SCREEN
VENT FAN
PUMP ROOM
36"
36"
36"
26"
VALVE
FLOAT PIPE
GAUGE PIPE
GATE
INTAKE 7'-4" x 4'-10"
WEIR IN LOWER SEWER TO DEFLECT DRY WEATHER FLOW TO INTERCEPTING SEWER
RELIEF CHAMBER AND GATE
TO RELIEVE THE LOWER SEWER IF THE STATION, THROUGH ACCIDENT, IS PUT OUT OF COMMISSION
SEWAGE PUMPING STATION
UNION PARK ST. AND ALBANY ST.
BOSTON, CITY PROPER
OCTOBER, 1915
DO NOT SCALE

FIG. 3.

as long as the intercepter will receive it. When the intercepter fills and begins to backflood it, a tide-gate closes and diverts the flow over a weir into the pump-wells of the pumping station, whereupon the pumps start up automatically and eject it into the South Bay through an outlet conduit separate from the overflow outlet of the sewer. The low-level line of main sewer consists of the following sizes:

873 linear feet of 7′ 4″ x 4′ 2″; 903 feet of 7′ 0″ x 4′ 2″; and 677 linear feet of 6′ 5″ x 4′ 2″.

With elevation 1.00 at the weir and 5.00 at Tremont St., the capacity of the portion between Albany St. and Harrison Ave., 873 ft. in length, is about 167 sec.-ft., and this amount was used for the design of the pumps.

If elevation 5.00 be retained at Tremont St. and the flow pumped to elevation 1.29 at the pumps, or about 1.59 at the weir, a maximum of 140 sec.-ft. can be carried from Tremont St. through the whole line with varying gradients.

Assuming all connections with contiguous sewer systems to be cut off, the present area draining into the low-level system at or above Tremont St. is 51.9 acres, of which 5.5 acres is street surface which should go into the high-level system.

The time of concentration at Tremont St. is about thirty minutes, allowing six or seven minutes initial time for water to reach the drains. This corresponds to a maximum rainfall rate of 2.5 in. per hour, or 2.5 sec.-ft. per acre. Figuring in the ordinary way by the rational method, omitting all street surfaces which go to the high level, and making reasonable allowance for future development, we get a run-off factor of 0.682. This applied to the rainfall rate of 2.5 ins. gives 1 705 sec.-ft. per acre. Applying this to the capacity of 140 sec.-ft. assumed for the sewer in Tremont St., shows the area which can be taken in at this point is 81.1 acres.

There are about 37.5 acres, total area, remaining to be taken in.

When all lines are built to connect up this additional area, the resulting net tributary area at Tremont St. will be about 82.4 acres.

The pumping station is located at the corner of Union Park and Albany streets. There are installed therein three 36-in. submerged centrifugal pumps, each of 67.7 sec.-ft., or 30 000 gals. per minute capacity, and one 26-in. pump with a capacity of 33.3 sec.-ft., or 15 000 gals. per minute, against a static head of 13½ ft.

The total capacity of the station is 236.4 sec.-ft., or 105 000 gals. per minute. Regarding one 36-in. pump as a spare, the normal capacity of the station is 168.7 sec.-ft., or 75 000 gals. per minute.

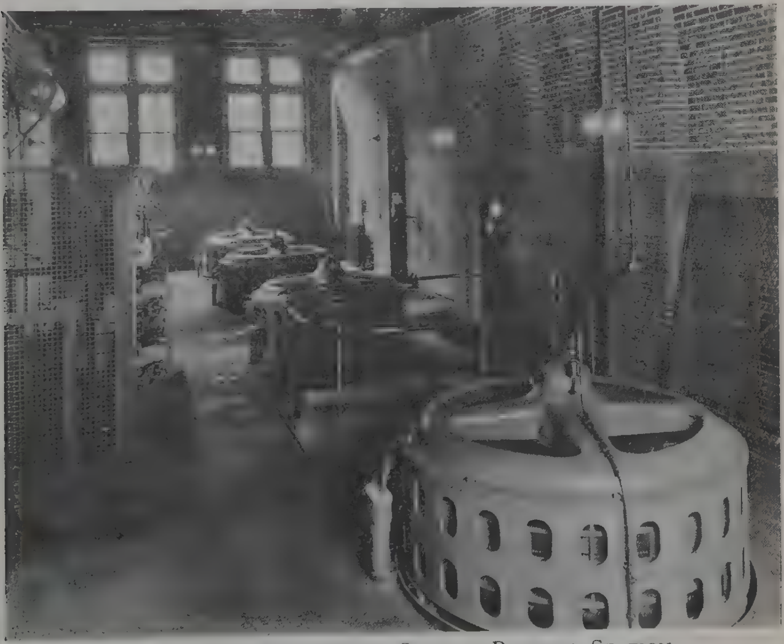

FIG. 4. MOTOR ROOM OF SEWAGE PUMPING STATION.

The pumps are electrically driven. The motors for the 36-in. pumps are 150-brake h.p., constant speed, squirrel-cage induction motors, having a synchronous speed of not more than 200 revolutions per minute, and a full load speed of about 194 revolutions per minute, when supplied with 3-phase, 60-cycle alternating current at 440 volts at the motor terminals. (See Fig. 4.)

The 26-in. pump has a similar motor of 75 h.p., having a synchronous speed of 240 revolutions per minute and a full load speed of about 233 R.P.M.

The total power required for the station, including the spare pump, is 525 h.p. The pumping machinery is automatic throughout, each motor being controlled by a float which throws a switch at a certain fixed elevation of the sewage in the pump-well.

The foundation for this station presented an interesting problem, the underlying material, shown by borings, for 37.5 ft. below street level (elevation 20.00) being a soft silt, except for a few feet of gravel, clay and ash filling on top. Then a stratum of 3.5 ft. of stiff blue clay was found, under which a soft clay or silt extended to hard bottom at a depth of 80 ft.

Two plans naturally suggested themselves; first, to drive comparatively short piles, stopping them in the stiff clay stratum; second, to drive long piles and trust to friction.

To test the practicability of the latter scheme it was determined to drive a test pile, allow it to rest a day or two and then load it until it yielded to determine its actual bearing strength. The results of the tests are shown by Fig. 5.

A pit was dug on the site of the proposed station and to the proposed grade of the foundation, and a test pile was driven 25 ft. below the bottom of the pit, the fall of the hammer and the resulting penetration being recorded for each blow. A long rod was driven into the head of the pile for convenience in observing settlement, and the pile was capped with a block of concrete. It was then loaded with pig-iron in 5-ton lots, with the following results:

Date.	Total Load, Tons.	Settlement. Feet.
	0.21	
Aug. 4, 1913.	5.43	0.005
6, 1913.	10.43	0.017
8, 1913.	15.43	0.020
11, 1913.	20.43	0.027
13, 1913.	25.43	0.032
15, 1913.	30.43	0.057
18, 1913.	35.43	0.159

At 25 tons loading, the yield began sensibly to increase.

The pile formula, —

$$\frac{(\text{Cubic root of fall in feet}) \times (\text{Weight of hammer in lbs.}) \times (0.023)}{\text{Last sinking in inches} + 1} = \text{safe load} \times 5,$$

gave about 4 tons as a safe load.

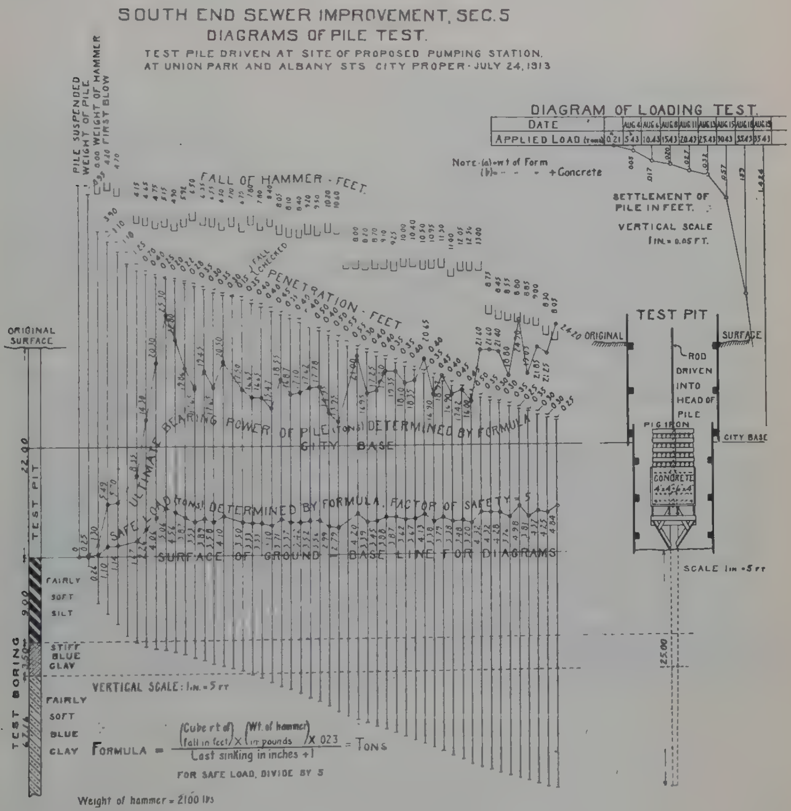
SOUTH END SEWER IMPROVEMENT, SEC. 5
DIAGRAMS OF PILE TEST.
TEST PILE DRIVEN AT SITE OF PROPOSED PUMPING STATION.
AT UNION PARK AND ALBANY STS CITY PROPER · JULY 24, 1913
PILE SUSPENDED
WEIGHT OF PILE
WEIGHT OF HAMMER
FIRST BLOW
FALL OF HAMMER - FEET
PENETRATION - FEET
FALL CHECKED
ULTIMATE BEARING POWER OF PILE (TONS) DETERMINED BY FORMULA
CITY BASE
SAFE LOAD (TONS) DETERMINED BY FORMULA, FACTOR OF SAFETY = 5
SURFACE OF GROUND = BASE LINE FOR DIAGRAMS
ORIGINAL SURFACE
TEST PIT
22.00
9.00
TEST BORING
FAIRLY SOFT SILT
STIFF BLUE CLAY
FAIRLY SOFT BLUE CLAY
VERTICAL SCALE: 1 in. = 5 ft
FORMULA = (Cube rt of fall in feet) X (Wt. of hammer in pounds) X 023 / Last sinking in inches + 1 = TONS
FOR SAFE LOAD, DIVIDE BY 5
Weight of hammer = 2100 lbs
DIAGRAM OF LOADING TEST.
DATE | AUG 4 | AUG 6 | AUG 8 | AUG 11 | AUG 13 | AUG 15 | AUG 18 | AUG 19
APPLIED LOAD (tons) | 0.21 | 5.43 | 10.43 | 15.43 | 20.43 | 25.43 | 30.43 | 35.43 | 35.43
Note (a) = wt of Form
(b) = " " " + Concrete
.005 .017 .020 .027 .032 .057 .153 1.424
SETTLEMENT OF PILE IN FEET.
VERTICAL SCALE 1 IN. = 0.05 FT.
ORIGINAL
SURFACE
ROD DRIVEN INTO HEAD OF PILE
PIG IRON
CONCRETE
CITY BASE
SCALE 1 in = 5 ft
25.00

FIG. 5.

It is a question whether any pile formula is applicable to a case like this, in which the pile does not bring up on anything resembling hard bottom. This pile, driven 25 ft. below the proposed grade of the foundation, of course pierced the clay stratum. It showed a little more resistance when going through it than when driven its full length. The problem was indeterminate, and its solution became a matter of judgment. It was the writer's preference to drive short piles, stopping them in the clay stratum, but this view did not prevail. Inasmuch as the pit for the substructure was to be sheathed with 6-in. grooved and splined Georgia pine, driven to the clay stratum, and therefore enclosing the soft material in a tight box, and as the foundation was to be a raft of reinforced concrete, 2½ to 3 ft. thick over the whole area of the box, it was finally determined to drive 25-ft. piles which would result in a load of 8 tons apiece.

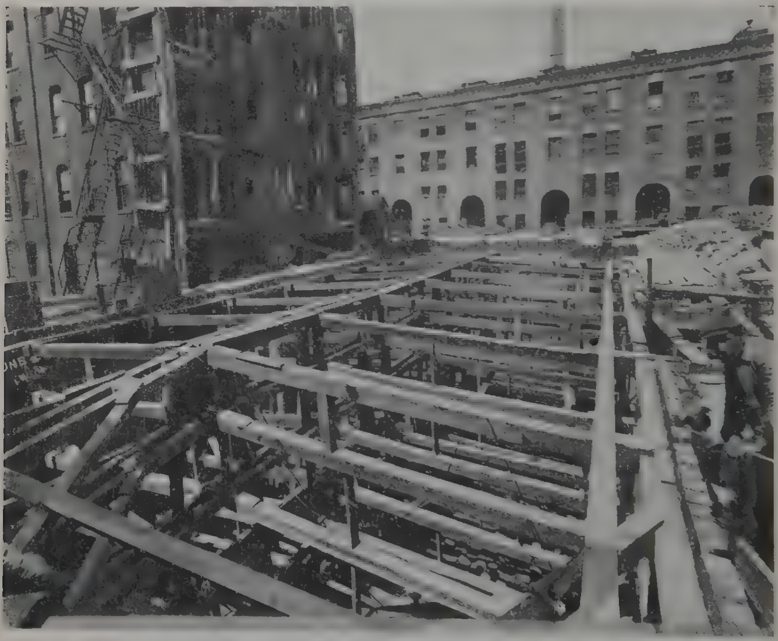

FIG. 6. EXCAVATION AT PUMPING STATION SITE, SHOWING UPLIFT OF BRACING.

The pressure on the sheeting was severe. The excavation was braced to a row of piles driven along the center line and was well cross-braced, horizontally and vertically. The piles started to rise in the center as indicated in Fig. 6, but this was checked by the prompt completion of the concrete foundation.

The concrete of the substructure was waterproofed with the Kennelly integral waterproofing, a liquid substance which is applied by mixing it with the water in the concrete. It is successful up to date, a few small leaks having developed, but having been stopped.

The superstructure is of brick, with a reinforced concrete roof, waterproofed in the same way, tarred and graveled.

The station was planned to have not only ample but some surplus capacity, for several reasons. First, the limits of the ultimate extension of the pumping system are indeterminate. There is every gradation in the amount of suffering or inconvenience which has been experienced. The localities which, in the judgment of the Sewer Division, most needed relief have been selected, but there are undoubtedly many others which are now excluded which will demand and receive the benefit of the new system. This conclusion is rendered more probable from the fact that a singular difficulty was encountered in investigating the conditions in the South End. It was anticipated that many people would claim to have suffered more severely than they really had, and demand that the benefit of the new system be extended to their premises, when it was doubtful if it was really necessary. Just the reverse was found to be the case, owners denying having had trouble even where it was known that the premises were subject to flooding. The explanation is that the whole region being depreciated by the very condition for which a remedy was sought, the estates were unprofitable as investments, were probably heavily mortgaged, and the owners feared that their small remaining equities would be wiped out by a heavy sewer assessment. Such an assessment would be unjust, because the city is now only tardily making good a service which it should have rendered always. If this view prevails, then, as soon as it is known that the benefit does not entail an assessment, and the benefit to those estates which are connected are observed, demands will be made for considerable extensions of the system.

Another reason to expect additional demands upon the system is found in the location of this Union Park St. system, between the Dover and Dedham streets system, in which tolerable conditions are maintained only by open connections with the intercepter. Now this sewer is too small for its present duty north of Dover St., and plans have long been in readiness for rebuilding or supplementing it. When this is done, as it must be very soon, the flow in the intercepter will be increased south of Dover St., and it will give less efficient aid in holding down the level in Dedham and Dover streets. Resort will then, of course, be had to the pumping station to help out these two systems in extreme cases of rain at high tide. Surplus capacity, which can be applied to helping out the worst portions of the Concord St. district, in addition to those already taken in, may also obviate the necessity of building another pumping station on that system, if the relief already given by the enlarged outlet, previously described, does not prove adequate.

As previously related, the station was put in operation just before the phenomenal rain of the first of last July. This rain was certainly all that could be desired as a test, and the station handled it successfully and easily, only two pumps, the 26-in. and one 36-in., being called into action. But the tide, although in, was falling, and not particularly high, being at 9.40 at the beginning of the heavy downpour and at 6.50 at the end. The real test will come with a heavy downpour and unusually high tide.

The contract price for the machinery was $34 856. The building, including substructure, cost about $50 000. The total cost of the project, sewers and all, to date, is about $400 000. Extensions now in sight may add $125 000, making a total cost of $525 000.

The construction of the sewers began in 1912, contracts for the machinery and station were let in 1913, and the station is now in commission, and is the largest station of its kind in the world.

Vol. II · DECEMBER, 1915 No. 10

BOSTON SOCIETY OF CIVIL ENGINEERS
FOUNDED 1848

PAPERS AND DISCUSSIONS

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LAYING A SMALL CAST-IRON PIPE ACROSS A NARROW STREAM.

By Charles R. Gow,* President, Boston Society of Civil Engineers.

Some years ago the writer had occasion to lay an 8-in. cast-iron pipe across a narrow stream. The pipe crossing was intended to form a part of a sewer line and had, therefore, to be laid to an established grade.

The stream was approximately 75 ft. in width and about 5 ft. in depth at the time when the work was done. As the river was used for boating, no obstruction which would interfere with such use was permitted. The bed of the stream was gravel overlaying a deposit of mud. The crossing was located close to and parallel with an existing highway bridge, from which all of the work was carried on.

A platform steam derrick mounted upon rollers was erected on the bridge so that it could be moved back and forth as the work progressed, the boom being long enough to reach out over the pipe location. A small orange peel bucket was used to remove the gravel slopes at either bank as well as to dredge the shallow trench necessary for the pipe. A pair of wooden leads containing a pile-driving hammer were suspended from the boom end, which was securely guyed in position, while spruce piles were driven in bents of two, the same being spaced 3 ft. on centers. There were 22 piles or 11 bents required in all.

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* Charles R. Gow Co., General Contractors, Boston.

It was necessary to cut and cap the piles at an exact grade, and as the cutting point was more than 5 ft. under water, the following method was devised to accomplish the purpose:

A light riveted steel cylinder 6 ft. in diameter and 10 ft. in length was lowered over a bent of two piles until it rested vertically upon the bottom. To seal the bottom edge, some sand and gravel was deposited around the outside. A pulsometer pump was then swung out by the derrick, the suction lowered into the cylinder, and by means of a steam connection with the hoisting engine the water was removed from the interior of the cylinder so that men could enter, cut the piles with an ordinary cross-cut saw, and cap them at the required grade with 6-in. by 6-in. timbers. When this operation was completed, the cylinder was withdrawn and placed over the next bent of uncut piles.

When all of the pile bents had been thus capped, the pipe was assembled on the bridge, the joints leaded and calked, and by means of the derrick and a guyed gin pole, the entire length of pipe was suspended over the desired location and lowered through the water till it rested on the pile caps previously placed. A diver was employed to wedge the pipe securely in place, this being the only part of the work on which a diver was used. The pipe was then backfilled with some of the dredged material.

The entire cost of this work exclusive of the cast-iron pipe and lead for joints was five hundred sixty-one dollars.

The accompanying illustration shows the pipe about to be lowered into place. The cylinder which was used for a temporary cofferdam in which to cut the piles is seen in the background. The photograph also clearly shows the method of suspending the pipe to avoid unduly straining the joints.

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PAPERS AND DISCUSSIONS

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EXTERNAL CORROSION OF WATER PIPE BY SULPHURIC ACID.

By Harrison P. Eddy,* Member Boston Society of Civil Engineers.

A rather unusual accident to the China Lake intake to the pumping station of the Kennebec Water District, Waterville, Me., has been brought to the attention of the writer. This 20-in. cast-iron pipe crossed over a small vitrified pipe which was used to convey the drip and waste sulphuric acid away from a shoddy mill. The vitrified pipe apparently was broken or clogged so that the acid escaped from it into the ground in the immediate vicinity of the main. An irregular hole about 2 in. by 1 in. was eaten entirely through the cast-iron pipe. At the edge of the hole the thickness of the pipe was not over one eighth of an inch, although this thickness gradually increased as the distance from the hole became greater. The effect of the acid on the outside of the pipe was noticeable for a distance of about three feet along its axis. The action of the acid upon the iron was greater in some places than others. There were several large bands of corrosion about the underside of the pipe, some of which were three or four inches wide, and apparently the pipe was being eaten into to a depth of as much as three eighths of an inch. The surface of the pipe, aside from the general irregularity of the bands and large areas eaten by the acid, was slightly rough but not materially different from the surface of ordinary cast-iron pipe. It was nowhere honeycombed as might be expected.

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* Of Metcalf & Eddy, Consulting Engineers, Boston.

The pipe was repaired by surrounding the portion affected by a split cast-iron sleeve four feet in length, packed with rubber gaskets and bolted together. The ends of the sleeve were leaded and calked in the usual way. At first the sleeve leaked at the joints, but these leaks stopped within twelve hours and the sleeve was entirely surrounded with Portland cement concrete well reinforced. The concrete sleeve was extended far enough in either direction to make certain that it protected the iron from any acid in the ground.

The vitrified acid pipe was diverted to a new location at some distance from the intake pipe. The soil in which the cast-iron pipe main and the vitrified pipe were laid was a mixture of sand and hardpan, fairly impervious to water, and not virgin soil, as there had been an old tannery in this location and various logs and timbers from the tannery were encountered in the excavation. Immediately below the vitrified pipe, a coarse water-bearing gravel was encountered. It is probable, however, that this stratum of gravel was fairly well cut off from the soil above by moderately impervious material.

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ABBREVIATIONS. — D. = Discussion; I. = Illustrated.
Names of authors are printed in *italics*.

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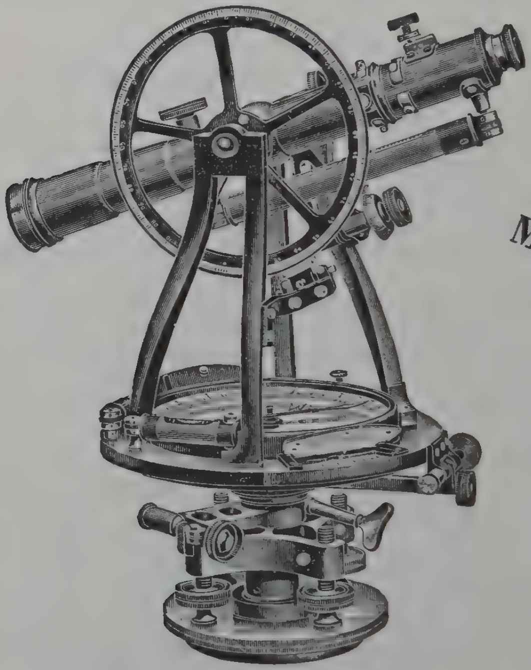

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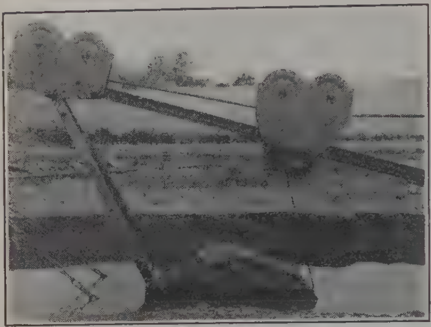

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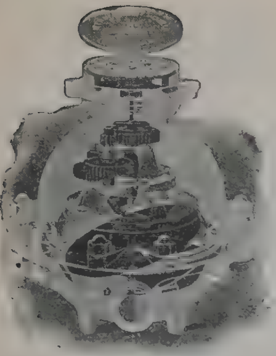

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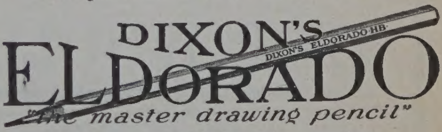

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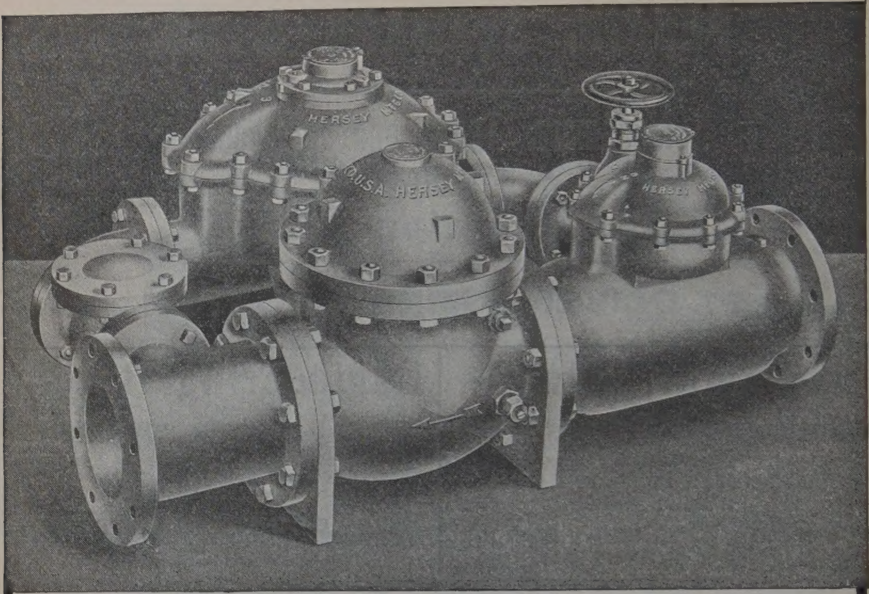

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